

東京理科大学「火災安全科学研究拠点」

Tokyo University of Science “Research Center for Fire Safety Science”

■ 研究成果概要報告書/ Report for Outline of Research Results

研究課題 Research Topic		FT-IR/Thermal Decomposition Analysis of Surface Combustion Characteristics in Flame Retardant Cross Laminated Timber with Intumescent Nano-Clay Composites	実施年度
			2018年度
研究代表者 Research Leader	所属 Affiliation	The Laboratory of Adhesion & Bio-Composites, Seoul National University	
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受入担当責任者 Organization	氏名 Name	Seoul National University	

1. 研究の背景および目的/ Background and Aim of Research

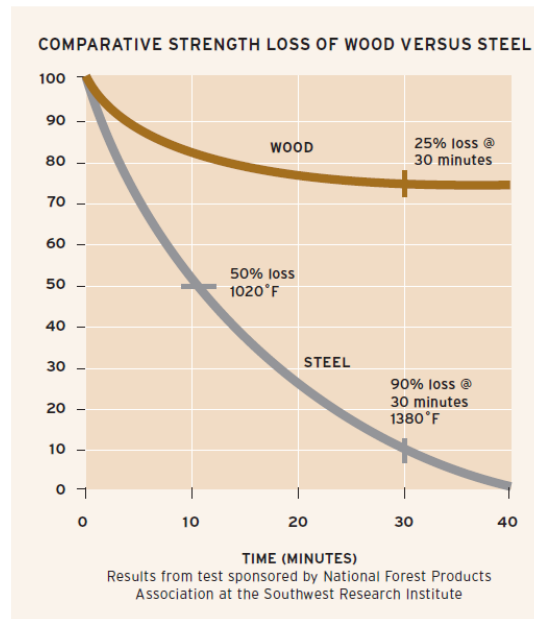
Glued laminated timber, also called glulam, is a type of structural timber product comprising a number of layers of dimensioned timber bonded together with durable, moisture-resistant structural adhesives.



By laminating a number of smaller pieces of timber, a single large, strong, structural member is manufactured from smaller pieces. These structural members are used as vertical columns or horizontal beams, as well as curved, arched shapes. Glulam is readily produced in curved shapes and it is available in a range of species and appearance

characteristics to meet varied end-use requirements. Connections are usually made with bolts or plain steel dowels and steel plates.

Glulam optimizes the structural values of a renewable resource – wood. Because of their composition, large glulam members can be manufactured from a variety of smaller trees harvested from second- and third-growth forests and plantations.

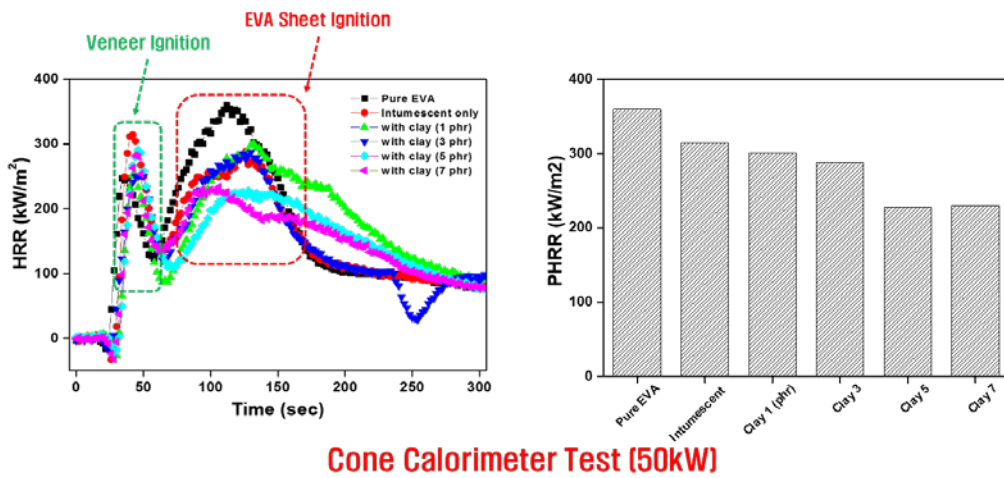


In order to take advantage of the laminated wood as a building interior material, analyzing the characteristics of the fire it is very important. Wood has very strong resistance to fire because wood form a carbide layer in the combustion process.

Despite these fire characteristics, if the laminated wood is exposed to fire, new forms of problems are occurred. When the glulam is continuously exposed to heat, the explosion of inside is occurred. These explosion phenomenon becomes greatly threaten safety of inside and rapidly destroy the structure.

Binder used for producing glulam is reason. Fully curing binder is degraded to single molecule by high temperature. Binder monomolecular is will be rapidly burned. As the internal combustion progresses, leading to the explosion.

Therefore, there is a need for research to analyze the combustion characteristics with degradation products of glulam. In particularly, any change of glulam it causes in the fire environment must analyzed through a quantitative evaluation.



Cone Calorimeter Test (50kW)

We have confirmed through preliminary studies that surface wood is vulnerable to initial burning. I think we need a new approach to overcome this. We wanted to study whether it is possible to strengthen the flame retardancy of wood using surface coating method.

2. 利用施設及び利用日/ Facility and Schedule

- SDT-FTIR/Cone-calorimeter 装置 (2018年12月12日 ~ 12月18日)
- SDT-FTIR/Cone-calorimeter 装置 (2019年1月22日 ~ 1月23日)

3. 実験方法・研究成果、および考察 (申請時の計画に対する達成度合いも含む)

※継続課題の場合は、前年度との関係性、進展度合いについても記載すること。

/ Method, results, and conclusions (degree of achievement compare to application)

For the test, thin plate test specimens were prepared as shown below. The mass was controlled at 1 g / sample to control the degree of surface coating.



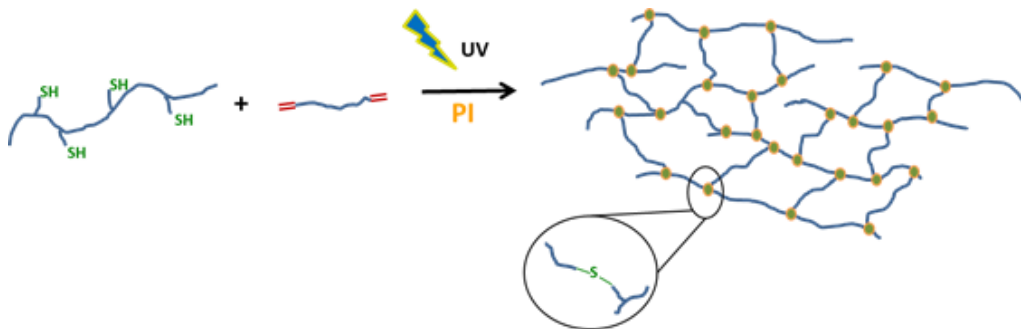
Test sample



Combustion evaluation residue

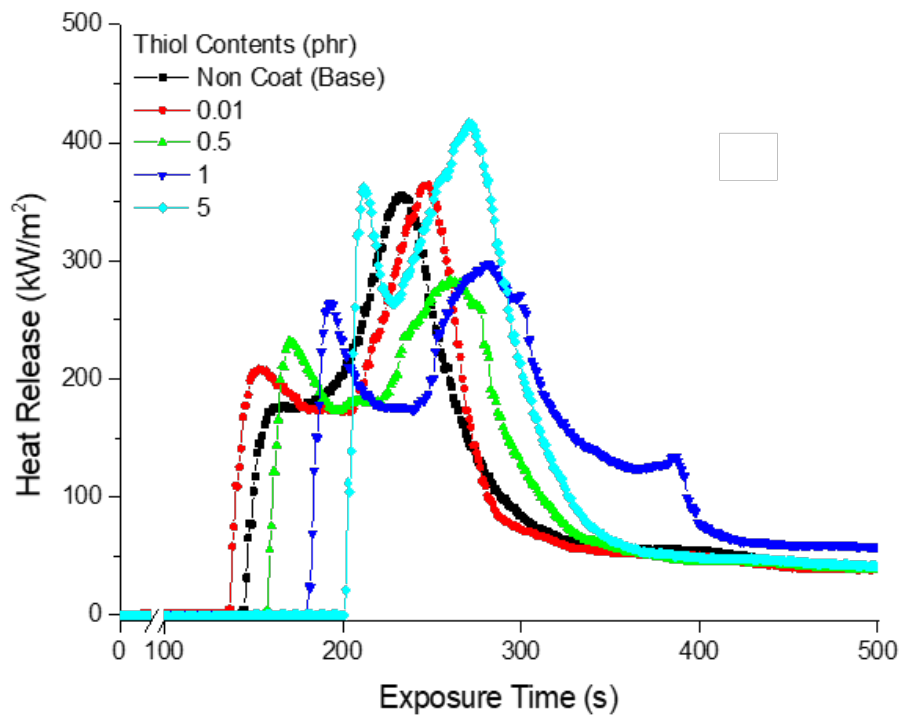
Above - Hard Maple, Down - White Oak

The main purpose of this study is to form a protective layer by using UV coating technology on the surface, and to control the content of thiol in this process to change the crosslink density. Since thiol acts as a crosslinking agent, the crosslinking density increases as the content increases.



<Scheme of cross linking system with thiol>

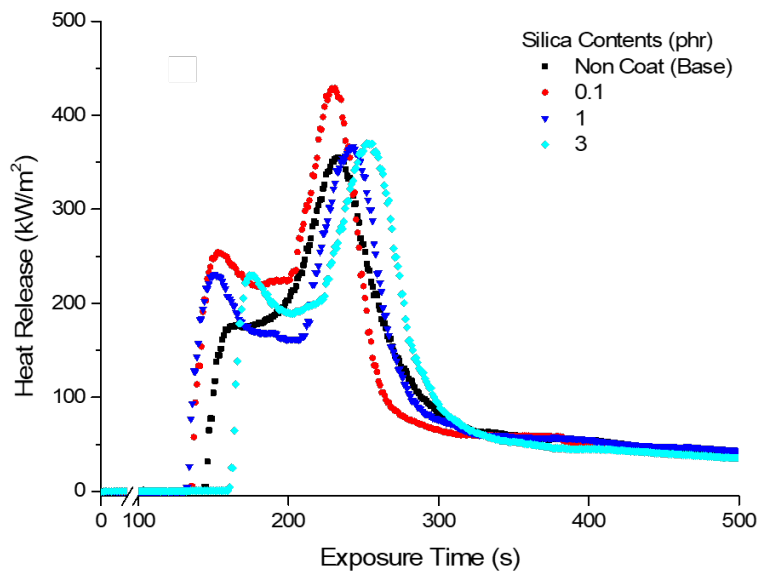
UV coatings are acrylate-based materials and are generally prone to combustion. When the content of thiol is small, the initial burning becomes faster and the maximum peak tends to increase after UV coating. When the content of thiol is increased, the hardening density is increased and the radical capturing property is strengthened, so that the initial combustion is delayed. When the content of thiol is increased to 5 phr, the initial combustion time tends to be delayed by 60 seconds or more.



< Change of combustion characteristics according to thiol content >

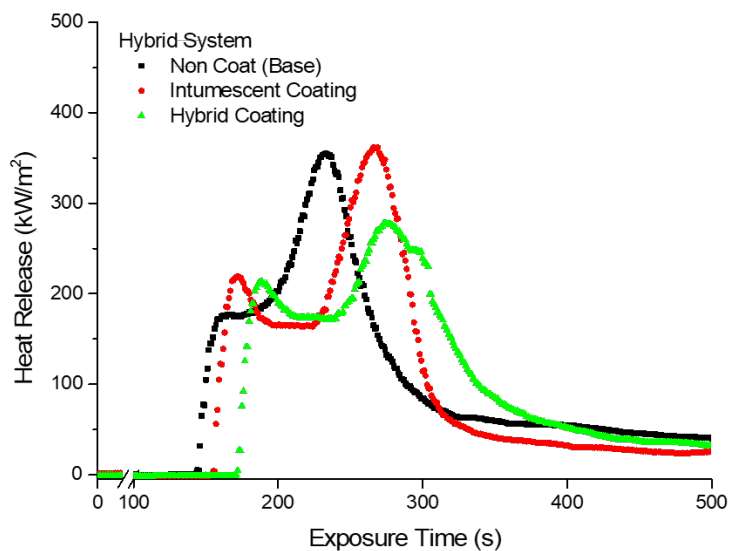
Silica acts to control the viscosity of the coating liquid and to lower the thermal conductivity. In general, silica is composed of small spherical particles. These particles combine with the surrounding binder to enhance the thermal decomposition properties or lower the thermal conductivity, thereby enhancing the heat resistance of the entire system.

When silica is used, there is little effect when the content is small. However, as the content increases, the effect of decreasing the maximum peak and delaying the initial combustion can be confirmed. Although it does not reduce the overall heat of combustion, it is possible to confirm the possibility of delaying the initial combustion.



< Change of combustion characteristics according to silica content >

In order to find a way to reduce the maximum peak while lowering the initial heat of combustion as a whole, we analyzed the combustion characteristics of a coating material based on an intumescent system on the surface and a mixture of this material and a UV coating. While the intumescent system tends to move the graph to the right as a whole, it can be seen that the combustion delay effect is very apparent in the hybrid system.



< Improvement of combustion characteristics by hybrid coating >

4. 今後の展望（今後の発展性，見込み等についても記述）

/ Future Perspectives

1. Analysis of change of combustion compound according to combustion characteristics
2. Analysis of correlation between hardening properties and performance of coating materials
3. Improvement of combustion characteristics of CLT by combined surface / deep treatment

5. 成果の公表状況（学会への発表，学術誌への投稿等を記述。予定も含む）

/ Publishing (presentation, paper, etc. incl. plans in the future)

1. Variation of Combustion Characteristics of UV Coating Materials with Curing Density (Submit 'Coatings')

6. 経費の使用状況/ Usage of Budget

expendables・Meeting・Printing		Travel expense		Personnel expenses	
Contents	Cost	Contents	Cost	Contents	Cost
FTIR用フィルター	189,756	SeungHan Shin	74,845		
FTIR用SO ₂ チェックガス	19,332	Ji-Won Park	130,940		
Subtotal	209,088	Subtotal	205,785	Subtotal	
Burden of Tokyo University of Science / Total 414,873 Yen					

Burden of 414,873 / Total Yen

以上